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Original research

DRUJ instability after distal radius fracture: A comparison between cases with and without ulnar styloid fracture

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ABSTRACT

Background: Because of the importance of the DRUJ in upper extremity function and the prevalence of distal radius fractures, either with or without ulnar styloid fracture, this study was designed to assess the relationship between ulnar styloid fracture and the incidence of DRUJ instability after treatment of distal radius fractures treated with ORIF (volar plate).

Methods: 112 patients suffering from type two and three distal radius fractures (Fernandez classification), were evaluated. Depending on the presence of ulnar styloid avulsion fracture, patients were divided into two groups: 86 cases with isolated radial fracture and 26 cases with a distal radius fracture accompanied by ulnar styloid fracture. All patients underwent distal radius fracture ORIF. CT scanning was done both immediately after surgery and 3 months post-op. DRUJ stability was examined using the modified radioulnar line method and the incidence of DRUJ instability was compared between the two groups.

Results: Immediate instability was seen in 11 patients. Three of these patients had concomitant ulnar styloid fracture and were excluded for further fixation. Three months later, another 9 cases were diagnosed with DRUJ instability, 2 of whom had concomitant ulnar styloid fracture and the other 7 suffered from isolated distal radius fracture. Chi-square test revealed no significant difference ($p < 0.05$). There were no cases of delayed union or non-union distal radius fracture.

Conclusion: Our study demonstrated that untreated stable or minimally displaced ulnar styloid fracture accompanied by distal radius fracture, has no adverse effect on DRUJ stability following ORIF of the radius.

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1. Introduction

Fracture of the distal radius is the most common type of fracture in the upper extremity.^{1–4} Because the radius plays a fundamental role in the stability of the wrist joint, preservation of ligamentous function of the wrist and the biomechanics of radiocarpal and radioulnar joints, anatomical reduction and correction of articular surface incongruity decreases the potential of degeneration and accelerates post-injury rehabilitation. The necessity of anatomic reduction of these fractures and its relation to functional outcomes have been demonstrated by many authors.⁵

Distal radius fracture is accompanied by several complications. Distal radioulnar joint (DRUJ) instability, the most disabling complication, is under debate as to both its nature and its necessity

for surgical reconstruction.^{5–8} The incidence of DRUJ instability was reported to be 10–19% after distal radius fracture.^{5,7,9} Both acute injuries and biomechanical changes related to chronic injuries result in pain and decrease in radiocarpal and radioulnar range of motion.^{7,10,11}

The DRUJ preserves its stability through articular surface congruity and with normal function of triangular fibrocartilage complex (TFCC).^{9,12,13} The ulnar head articulates with the sigmoid notch of the distal radius and the congruency between the bones provides some stability to the DRUJ, however this articulation is shallow and relies on only soft tissue stabilizers to maintain joint integrity.^{12,13} The triangular fibrocartilage complex (TFCC) is the most essential soft tissue stabilizer of the DRUJ.^{6,12,13} The dorsal TFCC is important in stabilizing the DRUJ during pronation while the volar TFCC is important in DRUJ stabilization during supination.^{12,13} This indispensable stabilizer is commonly injured in distal radius fractures, but unfortunately it is often overlooked in many distal radius

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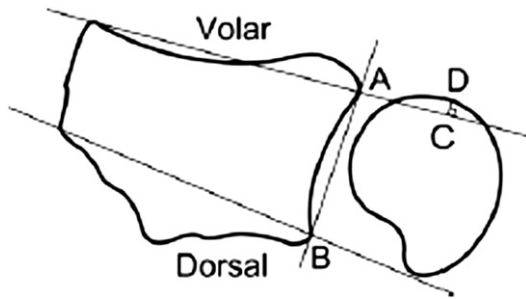


Fig. 1. DRUJ subluxation is diagnosed while the length of the DC is greater than one quarter of the diameter of the sigmoid notch (AB).

fixations⁶ and this leads to DRUJ instability in many cases. The incidence of TFCC injury in distal radius fracture was shown to be 30–70% in recent studies.¹⁴ Unrecognized DRUJ injuries cause motion restriction, joint surface incongruity, subluxation of the ulnar head and decreased grip strength.^{6,7,15–17} In addition, the DRUJ plays a critical role in normal forearm rotation⁸ and early treatment of acute injury provides better results than surgical management of chronic instability.¹² Since the TFCC originates from the base of the ulnar styloid, the fractures involving the proximal half of the ulnar styloid result in DRUJ instability.^{8,18–20}

Ulnar styloid fracture is a common associated injury in distal radius fractures,^{8,21,22} and is seen in 50–65% of these cases.²² The effects of this accompanying injury on functional outcomes and DRUJ stability are unclear.^{8,21,22} Some authors suggest that this fracture, while accompanying distal radius fractures, has little to no impact on radiographic studies or other clinical data.^{8,19,21,22} However others have demonstrated that ulnar styloid fracture can contribute to DRUJ instability, TFCC tear, ulnar-sided wrist pain, or weakness and restriction of wrist ROM.^{8,20–22} The literature suggests that displaced ulnar styloid fractures that lead to DRUJ instability must be treated with ORIF,²² however the treatment of non-displaced fractures is controversial.^{19,22} Since styloid fixation carries some risk of additional complications, it is important to determine if fixation of the ulnar styloid is necessary in patients with a stable DRUJ.^{21,22} The purpose of the current study is to determine whether non-displaced ulnar styloid fractures increase the risk of DRUJ instability.

2. Materials and methods

During the course of the study (August, 2009 to January, 2010) 128 patients suffering from type 2 and 3 distal radius fractures (based on the Fernandez Classification) presented to the emergency ward. The exclusion criteria included multiple trauma, young age, refusal to give consent, systemic disease, previous distal radius fracture in the same extremity, intraoperative distal radioulnar joint instability and associated displaced ulnar styloid fracture with or without DRUJ instability before

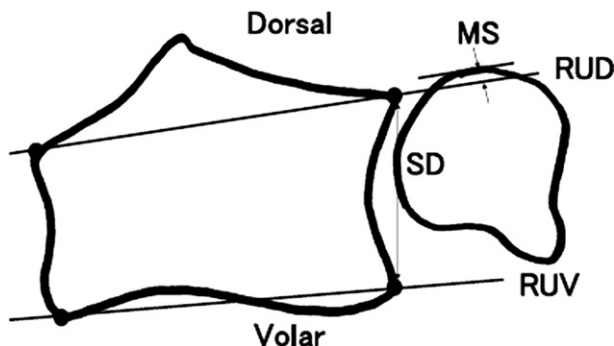


Fig. 2. Modified radioulnar line method.

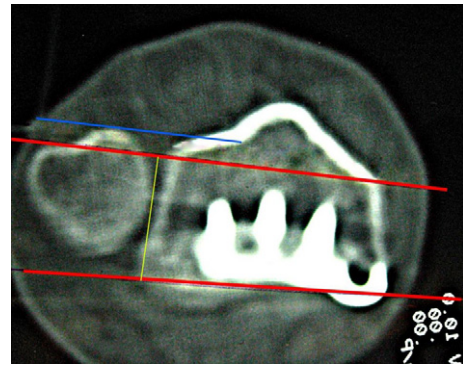


Fig. 3. A normal postoperative CT-scan.

and after distal radius fixation. Therefore 16 patients were excluded from our study: 2 cases due to multiple traumas, 1 for rheumatoid arthritis, 9 patients were excluded because of intraoperative instability and the other 4 for associated displaced ulnar styloid fracture.

Of the remaining 112 patients, 86 patients (59 men and 27 women) had isolated distal radius fracture and the other 26 (15 men and 11 women) had concurrent distal radius and ulnar styloid fracture. The mean age of isolated distal radius fracture was 29.41 ± 10.53 years and in concurrent radius and ulnar fractures it was 31.37 ± 14.15 years. All patients underwent open reduction and internal fixation with volar locking plate and anatomical reduction was confirmed with plain radiography.

Soon after the operation, DRUJ congruency was evaluated using CT scan^{23,24} and if instability was detected, the DRUJ was immobilized in a long arm cast with forearm supination for 6 weeks. Patients received follow up for 3 months at the final visit, DRUJ stability was re-evaluated again with CT scan. In this current study we evaluated DRUJ congruency using the modified radioulnar joint method (Fig. 1).^{23,25} The modified radioulnar line method is usually performed on the forearm in the neutral position, but maximum pronation was adopted in this study because dorsal subluxation of the ulnar head is greatest in maximum pronation. This method is displayed in Figs. 2 and 3. By constructing a line (RUD) through the dorsal ulnar and radial borders of the radius and a second line (RUV) through the volar ulnar and radial borders of the radius, the ulnar head lies between two lines when the DRUJ is congruent. Subluxation is diagnosed when the maximum width of the subluxed part of the ulna (MS) is larger than one quarter of the sigmoid notch diameter (SD). Finally, the collected data were analyzed using a chi-square test. The results were considered significant with a p -value < 0.05 . The level of evidence of this cohort study was 2B.

3. Results

Soon after the operation, computed tomography of the fractured wrist in neutral position was performed for each patient and DRUJ instability was examined. According to the modified radioulnar line method, performed in neutral position, 11 unstable DRUJs were detected. Three of those had concurrent ulnar styloid fracture and were therefore excluded. They underwent ulnar styloid ORIF. However, the remaining cases were treated with casting. Patients were followed up continuously for 3 months. At the final visit, computed tomography was repeated and DRUJ stability was re-evaluated. We found that 9 patients had DRUJ instability and lost joint congruity. Two of them had an ulnar styloid fracture. Another 2 patients with isolated distal radius fracture showed early post-operative DRUJ instability and casting failed to treat their injury (Fig. 4). All but one patient who showed DRUJ instability on CT scan had pain and limited range of motion. No cases of delayed union or non-union were seen. The chi-square test revealed that the difference between the two groups was not statistically significant ($p < 0.05$).

4. Discussion

It seems that concurrent ulnar styloid and distal radius fracture increase the potential for DRUJ instability, because stabilizers of the DRUJ originate from the ulnar styloid.^{8,18–20} Previous authors have obtained contradictory results in their studies about the necessity

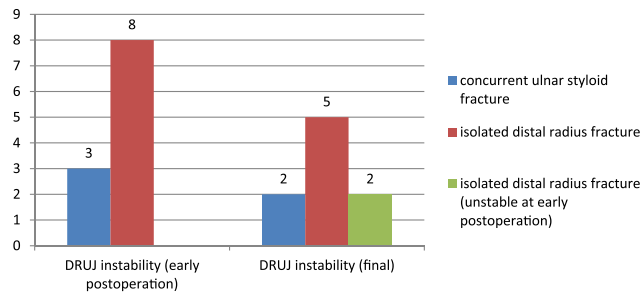


Fig. 4. Incidence of DRUJ instability in early and 3 months postoperatively.

for treating ulnar styloid fractures with ORIF. Some have demonstrated that an accompanying styloid fracture increased the risk of DRUJ instability.^{8,20–22} Others have ruled out this idea.^{8,19,21,22} Regarding these controversial conclusions on DRUJ instability treatment and its increased incidence in distal radius fracture, it is necessary to determine whether concurrent ulnar styloid fracture should be treated operatively. In this study, cases with concurrent ulnar styloid fracture, which ought to be fixed surgically (ulnar styloid base fracture with DRUJ instability or fractures with displacement greater than 2 mm²¹) had been excluded. So the patients examined had intact DRUJ stabilizer constructions.

In this study, we found that the incidence of DRUJ instability in both groups was the same. It seems that this finding is due to the followings:

- 1) Distal radius fracture ORIF with volar locking plate corrected the anatomical abnormalities which resulted in DRUJ instability (dorsal angulation > 5 degrees, radial shortening \geq 4 mm and lateral shift \geq 2 mm)⁵ and anatomical reduction was achieved.
- 2) Although soft tissues stabilizing the DRUJ originate from the ulnar styloid and its fracture can disrupt DRUJ stability, the origin of distal radioulnar ligament and triangular fibrocartilage were not injured; probably because in our study all ulnar styloid fractures were stable or minimally displaced.

Our study supports the findings of Sammer et al.²² and Kim et al.²¹ Sammer et al. evaluated the outcome of ulnar styloid fractures without DRUJ instability based on patient-rated criteria after treating distal radial fracture with ORIF. Eighty-eight cases out of 144 had concurrent ulnar styloid fracture. These patients were treated with ORIF of the distal radius. The authors followed up patients for one year and evaluated the results using the Michigan hand outcomes questionnaire (MHQ). They found that no patients had DRUJ instability. Furthermore, the size of styloid fracture, and the degree of styloid displacement and healing status did not affect the final outcome. They concluded that ulnar styloid fracture in patients treated with distal radius fracture ORIF did not affect subjective results.²² Also Kim et al. demonstrated that an accompanying ulnar styloid fracture in patients with rigid distal radial fixation did not affect DRUJ stability, so surgical fixation of ulnar styloid was not needed. They concluded that fractures of the ulnar styloid did not need surgical fixation, as the amount of displacement and level of fracture did not affect the final outcome.²¹

Despite these findings some authors have demonstrated that an accompanying ulnar styloid fracture was a predictor of poor results.^{5,27} Stoffelen et al. evaluated 272 distal radial fractures in a prospective study. They concluded that an avulsed ulnar styloid contributed to poor results and this effect is because of distal radioulnar joint involvement, but they made no mention of the method of fracture fixation in their series.⁵

Richards et al. evaluated 118 cases with distal radius fracture arthroscopically and found that ulnar styloid fracture did not affect TFCC and concluded that ulnar styloid fracture did not predict TFCC injury.²⁶ In contrast, Lindau et al. suggest that the presence of an ulnar styloid avulsion fracture might be an indication of TFCC injury.²⁷ It is important to emphasize that Richards et al.'s findings are more exact, since they examined the patients arthroscopically.

In the current study we assessed DRUJ instability using computed tomography. It is an accurate and reliable method to examine the congruity of the joint which increases the power of this study and we strongly suggest this method be used in assessing patients with distal radius fractures. Of note, all but one patient with instability on CT scanning, suffered from pain and limited range of motion at the final visit. This finding confirms the efficacy of CT scan for evaluating DRUJ instability. We acknowledge some limitations of our study. We did not report or compare grip strength, pinch strength, range of motion, or pain using a reliable score for our two groups. Like the study of Kim et al.²¹ its other weakness is its inability to identify the risk of chronic instability of the DRUJ which is necessary to evaluate long term results. One improvement we could make in our study is to increase the number of patients suffering from distal radius fracture accompanied by ulnar styloid fracture compared to those affected with isolated distal of radius fracture which might have led to statistically significant results.

In conclusion, our study demonstrated that untreated stable or minimally displaced ulnar styloid fracture accompanied by distal radius fracture, had no adverse effect on the stability of the DRUJ after ORIF of the radius.

Conflicts of interest

There was no conflict of interest.

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Ethical approval

The proposal was referred to ethical committee of Shahid Beheshti university of medical sciences and approved by that committee.

Author contribution

Gholam Hosein Kazemian; Hooman Bakhshi; Mohammad Emami Tehrani moghadam: Study design and data gathering.

Mohammad M Omidian; Farshad Safdari; Iman Mohammad-pour; Matt Lilley: Data analysis, writing and editing.

References

1. Cole DW, Elsaidi GA, Kuzma KR, Kuzma GR, Smith BP, Ruch DS. Distal radioulnar joint instability in distal radius fractures: the role of sigmoid notch and triangular fibrocartilage complex revisited. *Injury Int J Care Injured* 2006;**37**:252–8.
2. Wong KK, Chan KW, Kwok TK, Mak KH. Volar fixation of dorsally displaced distal radial fracture using locking compression plate. *J Orthop Surg* 2005;**13**(2):153–7.
3. Eberl R, Singer G, Schalamon J, Petnehazy T, Hoellwarth ME. Galeazzi lesions in children and adolescents; treatment and outcome. *Clin Orthop Relat Res* 2008;**466**:1705–9.
4. Lam F, Jaysekerab N, Karmani S, Jupiter JB. What's new in the treatment of distal radius fractures? *Curr Orthop* 2006;**20**:208–11.
5. Stoffelen D, De Smet L, Broos P. The importance of the distal radioulnar joint in distal radial fractures. *J Hand Surg (Br Eur)* 1998;**23-B**(4):50–1.
6. Mulford JS, Axelrod TS. Traumatic injuries of the distal radioulnar joint. *Orthop Clin N Am* 2007;**38**:289–97.
7. Geissler WB, Fernandez DL, Lamey DM. Distal radioulnar joint injuries associated with fractures of the distal radius. *Clin Orthop Relat Res* 1996;**327**:135–46.

8. May MM, Lawton JN, Blazar PE. Ulnar styloid fractures associated with distal radius fractures: incidence and implications for distal radioulnar joint instability. *J Hand Surg (Am)* 2002;**27**(6):965–71.
9. Tsai PC, Paksima N. The distal radioulnar joint. *Bull NYU Hosp Jt Dis* 2009;**67**(1):90–6.
10. Ozer K, Scheker LR. Distal radioulnar joint problems and treatment options. *Orthopedics* 2006;**29**:38.
11. Crisco JJ, Moore DC, Elisabeta Marai G, Laidlaw DH, Akelman E, Weiss A-PC, et al. Effects of distal radius malunion on distal radioulnar joint mechanics—an in vivo study. *J Ortho Res*; 2007:547–55.
12. Kihara H, short WH, Werner FW, Fortino MD, Palmer AK. The stabilizing mechanism of the distal radioulnar joint during pronation and supination. *J Hand Surg* 1995;**20**(6):930–6.
13. Schuind F, An KN, Berglund L, Rey R, Cooney 3rd WP, Linscheid RL, et al. The distal radioulnar ligaments: a biomechanical study. *J Hand Surg* 1991;**16A**: 1106–14.
14. Buchholz RW, Heckman JD, Court-Brown C. Rockwood and Green's *Fractures in adults*. Philadelphia: Lippincott Williams & Wilkins; 2006.
15. Scheker LR, Ozer K. Ligamentous stabilization of the distal radioulnar joint. *Tech Hand&Up Ext Surg* 2004;**8**(4):239–46.
16. Fitzgerald BT, Hofmeister EP. Hand and wrist in athletes; update on distal radioulnar joint instability. *Curr Orthop Prac* 2009;**20**(4):404–8.
17. Johnston K, D'A Durand, Hildebrand KA. Chronic volar distal radioulnar joint instability: joint capsular plication to restore function. *J Can Chir* 2009;**52**(2):112–8.
18. Nakamura R, Horii E, Imaeda T, Nakao E, Shionoya K, Kato H. Ulnar styloid malunion with dislocation of the distal radioulnar joint. *J Hand Surg (Br)* 1998;**23**(2):173–5.
19. Buijze GA, Ring D. clinical impact of united versus nonunited fracture of the proximal half of the ulnar styloid following volar plate fixation. *J Hand Surg (Am)* 2010;**35**(2):223–7.
20. Mirarchi AJ, Hoyer HA, Knutson J, Lewis S. Cadaveric biomechanical analysis of the distal radioulnar joint: influence of wrist isolation on accurate measurement and the effect of ulnar styloid fracture on stability. *J Hand Surg* 2008;**33A**(5):683–90.
21. Kim JK, Koh Y-D, Do N-H. Should an ulnar styloid fracture be fixed following volar plate fixation of a distal radial fracture? *J Bone Jt Surg (Am)* 2010;**92**: 1–6.
22. Sammer DM, Shah HM, Shauver MJ, Chung KC. The effect of ulnar styloid fractures on patient-rated outcomes after volar locking plating of distal radius fractures. *J Hand Surg* 2009;**34A**:1595–602.
23. Henmi S, Yonenobu K, Akita S, Kuroda Y, Yoshida K. Diagnosis of distal radioulnar joint subluxation in patients with rheumatoid wrist by computed tomography. *Mod Rheumatol* 2007;**17**:279–82.
24. Rimondi E, Moio A, Busacca M, Tognetti A, Nigrisoli M, Tigani D, et al. Significance of computerized tomography in the diagnosis of post-traumatic proximal carpal instability. *Radiol Med* 1998 Sep;**96**(3):190–7.
25. Kim JP, Park MJ. Assessment of distal radioulnar joint instability after distal radius fracture: comparison of computed tomography and clinical examination results. *J Hand Surg* 2008;**33A**:1486–92.
26. Richards RS, Bennett JD, Roth JH, Milne Jr K. Arthroscopic diagnosis of intra-articular soft tissue injuries associated with distal radial fractures. *J Hand Surg (Am)* 1997;**22**:772–6.
27. Lindau T, Hagberg L, Adlercreutz C, Jonsson K, Aspenberg P. Distal radioulnar instability is an independent worsening factor in distal radial fractures. *Clin Orthop Relat Res* 2000;**376**:229–35.